

From the INTERNATIONAL BUREAU

PCT

## NOTIFICATION OF ELECTION

(PCT Rule 61.2)

To:

Assistant Commissioner for Patents  
United States Patent and Trademark  
Office  
Box PCT  
Washington, D.C.20231  
ETATS-UNIS D'AMERIQUE

in its capacity as elected Office

Date of mailing (day/month/year) 04 July 2000 (04.07.00)	
International application No. PCT/EP99/08900	Applicant's or agent's file reference TS 0762 PCT
International filing date (day/month/year) 04 November 1999 (04.11.99)	Priority date (day/month/year) 06 November 1998 (06.11.98)
Applicant BOUMA, Jacob, Hendrik et al	

1. The designated Office is hereby notified of its election made:

☒ in the demand filed with the International Preliminary Examining Authority on:

17 May 2000 (17.05.00)

☐ in a notice effecting later election filed with the International Bureau on:2. The election ☒ was☐ was not

made before the expiration of 19 months from the priority date or, where Rule 32 applies, within the time limit under Rule 32.2(b).

The International Bureau of WIPO 34, chemin des Colombettes 1211 Geneva 20, Switzerland	Authorized officer Claudio Borton
Facsimile No.: (41-22) 740.14.35	Telephone No.: (41-22) 338.83.38



REC'D 29 DEC 2000

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## INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference TS 0762 PCT	<b>FOR FURTHER ACTION</b> See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)	
International application No. PCT/EP99/08900	International filing date (day/month/year) 04/11/1999	Priority date (day/month/year) 06/11/1998
International Patent Classification (IPC) or national classification and IPC B04C5/15		
Applicant SHELL INTERNATIONALE RESEARCH MAATS..B.V...et al.		



1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.
2. This REPORT consists of a total of 5 sheets, including this cover sheet.

- ☐ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

These annexes consist of a total of sheets.

3. This report contains indications relating to the following items:

- I ☒ Basis of the report
- II ☐ Priority
- III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
- IV ☐ Lack of unity of invention
- V ☒ Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
- VI ☐ Certain documents cited
- VII ☒ Certain defects in the international application
- VIII ☐ Certain observations on the international application

Date of submission of the demand 17/05/2000	Date of completion of this report 22.12.2000
Name and mailing address of the international preliminary examining authority:  European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized officer Koob, M Telephone No. +49 89 2399 2080 



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP99/08900

## I. Basis of the report

1. This report has been drawn on the basis of *(substitute sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to the report since they do not contain amendments (Rules 70.16 and 70.17).):*

### Description, pages:

1-8 as originally filed

### Claims, No.:

1-7 as originally filed

### Drawings, sheets:

1/1 as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

These elements were available or furnished to this Authority in the following language: , which is:

- ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).
- ☐ the language of publication of the international application (under Rule 48.3(b)).
- ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

- ☐ contained in the international application in written form.
- ☐ filed together with the international application in computer readable form.
- ☐ furnished subsequently to this Authority in written form.
- ☐ furnished subsequently to this Authority in computer readable form.
- ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.
- ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

- ☐ the description, pages:
- ☐ the claims, Nos.:



# INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/EP99/08900

☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)):

*(Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)*

6. Additional observations, if necessary:

## V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

### 1. Statement

Novelty (N)	Yes:	Claims	1-7
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-7
Industrial applicability (IA)	Yes:	Claims	1-7
	No:	Claims	

2. Citations and explanations  
**see separate sheet**

## VII. Certain defects in the international application

The following defects in the form or contents of the international application have been noted:  
**see separate sheet**





Reference is made to the following documents:

D1: US-A-4 446 107

D2: EP-A-0 517 965

## **V. Reasoned statement**

1. The subject-matter of **claims 1-3** does not involve an inventive step in contradiction to Article 33(3) PCT.
- 1.1 The document **D1** discloses a cyclone separator for separating solids from a gas-solid containing feed, comprising:
  - an upright hollow circular housing (figure 3)
  - a dipleg (2) with a lower part (figure 3; angled tube)
  - a flapper valve (4)
- 1.2 The subject-matter of **claim 1** differs from **D1** in the diameter of the dipleg increasing from the top of the lower part to the lower end of the dipleg.
- 1.3 The technical problem to be solved is to prevent clogging of solid particles being collected above the valve (page 1, line 24 to page 2, line 7).
- 1.4 The document **D2** relates to a hydrocyclone recovering potato starch having a dipleg (6+7) with a conical lower part (7) with a downwardly increasing diameter (figure). An advantage of this design is, among others, that it does not easily get clogged (column 2, lines 14-17). As **D2** relates to the similar technical field and solves the same problem the combination of **D2** and **D1** is obvious.
- 1.5 The subject-matter of **claims 2-3** consists in the definition of specific angles for the increasing diameter of the lower part, namely 0.2°-4° resp. 0.5°-2°. **D2** proposes only preferably an angle between 5° and 35° (column 1, lines 32-33) but refers in general to all angles (see claim 1). The use of the claimed angles, not producing any unexpected effect, is therefore obvious.



2. The subject-matter of **claim 4**, the modification of an existing cyclone having an cylindrical dipleg to a cyclone according to **claims 1-3**, is not inventive as **claims 1-3** are not inventive.
3. The subject-matter of **claim 5** is not inventive as the cyclone according to **claims 1-3** is not inventive and the use of the cyclone for fluid catalytic catalysts is known from **D1**, column 1, line 14. The additional matter is a definition of parameters of the process in wide ranges which are seen as being normal working conditions. In case of disagreement the applicant should provide an evidence that these are special working conditions not disclosed in the prior art and producing an unexpected effect.
4. The subject-matter of **claims 6 and 7** is not inventive as the cyclone according to **claims 1-3** is not inventive and the use of the cyclone for fluid catalytic catalysts as well as the use within a vessel in which solids are disposed is known from **D1** (column 1, line 14 and figure 3).

#### **VII. Certain defects**

1. The independent claims are not filed in the two-part form in accordance with Rule 6.3(b) PCT, which in the present case would be appropriate, with those features known in combination from the prior art being placed in a preamble (Rule 6.3(b)(i) PCT) and with the remaining features being included in a characterising part (Rule 6.3(b)(ii) PCT).
2. The features of the claims are not provided with reference signs placed in parentheses (Rule 6.2(b) PCT).



WORLD INTELLECTUAL PROPERTY ORGANIZATION  
International Bureau

**FOR THE PURPOSES OF INFORMATION ONLY**

Codes used to identify States party to the PCT on the front pages of pamphlets publishing international applications under the PCT.

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EE	Estonia	LR	Liberia	SG	Singapore		

1/PRTS

WO 00/27538

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## SEPARATOR APPARATUS

The invention is directed to a cyclone separator apparatus for separating solids from a gas-solid containing feed. The invention is also directed to the use of such a cyclone separator in a fluid catalytic cracking process (FCC process).

Such an apparatus is described in US-A-4871514. This patent publication describes a cyclone separator which is used in a fluid catalytic cracking process to separate catalyst from the gaseous hydrocarbon products. The cyclone separator has a dipleg which has at its lower end a flapper valve. Flapper valves are also referred to a trickle valves. In normal operation the valve is in a closed position and catalyst will accumulate in the dipleg until it reaches a predetermined height in the dipleg. At this predetermined height the weight of the catalyst above the flapper valve will overcome the biasing effect holding the valve closed so that the valve opens and catalyst is released from the dipleg. In normal operation this sequence of steps will continue to take place. EP-A-383523, EP-A-488607 and US-A-4446107 are other publications describing cyclones having a dipleg and a trickle or flapper valve at the lower end of the dipleg.

A problem often encountered with these cyclones is that the dipleg is filled with catalyst while the flapper valve remains closed. When a dipleg is clogged in such a fashion the cyclone will not function in an optimal manner as a solid-gas separator and the fluid catalytic cracking process will have to be shut down in order to overcome the clogging. Because FCC processes are expected to run many months and even years between planned

shutdowns any unexpected shutdown will cause considerable economic damage.

The object of this invention is to provide a cyclone separator having improved reliability, i.e. a separator which does not have the clogging problems as described above. It has now been found that when the following apparatus is used less clogging of the dipleg will occur.

A cyclone separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the cyclone separator comprising an upright hollow circular housing fluidly connected to a dipleg having at its lower end a flapper valve, wherein the dipleg has a lower part, which lower part has a diameter which increases from the top of the lower part to the lower end of the dipleg.

The cyclone separator according to the invention has an upright hollow circular housing. The diameter of the housing may vary and preferably the housing will have an upper part of constant diameter (D3) and a lower part of, suitably continuously, declining diameter resulting in a frusto conical form. Diameter D3 suitably has a dimension of between 0.5 and 3 metre. The diameter (D4) at the lower end of the housing is suitably about the diameter of the dipleg connected to said lower end. In another embodiment a dust chamber is present between the lower part of the housing and the upper part of the dipleg. Such a dust chamber has as a rule a larger diameter (D5) than the diameter (D1) of the top end of the dipleg. The dust chamber suitably has a conical formed bottom which allows the solids to flow towards the inlet of the dipleg. The diameter (D1) of the top end of the dipleg may be constant for obvious structural advantages and has suitably a value of between 0.05 and 0.3 metres. The various dimensions of the cyclone will depend on the required separation efficiency and feed characteristics



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and can be calculated by well known standards as described Pages 82-88 of Section 20 of Perry's Chemical Engineers' Handbook, Sixth edition, McGraw Hill 1984.

5 The cyclone separator according to the invention has a dipleg consisting of an upper part and a lower part, wherein the lower part has a diameter which increases from top of the lower part to the lower end of the dipleg. The length of the upper part will be referred to as 'L'. The length of the lower part may be zero.. Typical lengths (L) of the lower part are between 0.1 and 1.5 metre, and preferably between 0.2 and 1 metre.

10 The diameter of the lower part will preferably continuously increase from top of the lower part to lower end of the dipleg. The angle (H) thus formed between the inner surface of the lower part of the dipleg and the vertical axis (Ax) is suitably between 0.2° and 4° and more preferably between 0.5° and 2°.

15 The lower end of the dipleg will consist of a flapper valve. The design of this flapper valve will partly depend on the design of the outlet opening of the dipleg. For example, the outlet opening of the dipleg may lie in a horizontal plane or in a vertical plane or in any plane between horizontal and vertical. Examples of possible designs which are associated with these possible openings are described in the afore mentioned publications EP-A-383523, EP-A-488607 and US-A-4446107. Some designs for the outlet opening include some sort of bend of this dipleg at the lower end. Within the meaning of this invention the lower part of the dipleg is the vertically positioned lower part. This of course does not exclude that the non-vertical lower end part may not have some kind of tapered design. The invention is especially directed to diplegs which have only a vertical lower end, wherein the openings may lie in any plane as discussed above.

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The invention is also directed to retrofitting an existing cyclone separator having a dipleg, preferably having the dimensions as described above but with a dipleg of constant diameter, by modifying the lower part of the dipleg in order to arrive at the cyclone separator according to this invention. The flapper valve may be of any one of the known designs.

The inlet means in a cyclone separator for the gas-solids feed are arranged in such a manner that, in use, a swirl movement in the tubular housing of the cyclone occurs. The swirl or rotating movement will cause the solids to be directed to the outer wall of the tubular housing where they slide down to be collected, optionally in a dust hopper. From such a dust hopper the solids are withdrawn from the cyclone by means of the dipleg, also referred to as standpipe. The swirl movement can be obtained by an axial or tangential inlet of the feed. If the feed enters the cyclone axially swirl imparting means will be present in the upper part of the tubular housing in order to impart on the downwardly moving feed a swirl or rotating movement.

The invention is also directed to a gas/solids separation process making use of the cyclone as described above, wherein a pressure difference exists between the cyclone housing and just beneath the outlet opening of the dipleg of between 1000 Pa and 40000 Pa, the solids preferably have a diameter ranging between  $1 \cdot 10^{-6}$  m and  $200 \cdot 10^{-6}$  m and wherein the solids are fluid catalytic catalysts of which the external surface consists predominately of a matrix material of the catalyst. Examples of possible matrix materials are clays, i.e. kaoline or meta-kaoline, alumina, silica, silica-alumina, magnesia, titania, zirconia and mixtures thereof. It has been found that when the cyclone separator according to the invention is used for this process less clogging

occurs compared to when a cyclone having comparable dimensions but not having the tapered dipleg.

The cyclone separator according to the invention is preferably used in processes, preferably a fluid catalytic cracking process, where the dipleg of the cyclone is not easily inspected when the cyclone is in use. This is for example the situation in which the lower end of the dipleg is located within a vessel in which the separated solids are disposed in. Examples of such vessels in a fluid catalytic cracking process are reactor/stripping vessels, regenerator vessels and catalyst storage vessels.

A fluid catalytic cracking process generally comprises a reactor in which catalyst particles and gaseous hydrocarbons are contacted. The reactor is generally a vertically positioned tubular reactor often referred to as the riser reactor through which catalyst and reactants co-currently flow in an upwards direction. At the end of the riser the catalyst particles are separated from the reactor effluent. This separation is usually effected by means of one or more separation stages. The separated catalyst particles are collected in a stripping vessel. In this vessel the catalyst particles are stripped with a water containing gas to separate any hydrocarbons from the catalyst. Stripping is suitably performed in a fluidized bed wherein the stripping gas is used as the means to fluidize the catalyst particles. The stripped catalyst particles are subsequently send to a regenerator vessel in which any coke is removed from the catalyst by means of combustion. The regenerator is suitably operated as a fluidized bed wherein the combustion gases, normally comprising oxygen, are used as means to fluidize the catalyst particles. The stripped and regenerated catalyst is reused in the process. In both stripping vessel and regenerator vessel the cyclone

separator according to the invention may be suitably used.

In a preferred embodiment the cyclone separator according to the invention is used as a secondary cyclone to separate catalysts from the reactor riser effluent of a FCC process. In this embodiment the separation of catalyst from the reactor effluent is performed by means of a first separation which separates the bulk of the catalyst, followed by a secondary cyclone which separates most of the remaining catalyst particles. The first separator may be a cyclone or any other gas/solids separation means. Examples of such FCC configurations are described in the earlier cited patent publications US-A-5055177, US-A-5391289, EP-A-309244, EP-A-299650 and EP-A-275158.

In another preferred embodiment the cyclone separator according to the invention is used as a primary and especially as a secondary cyclone to separate FCC catalyst particles from the gaseous effluent of a FCC regenerator.

The invention shall be further elucidated by means of the following figures. Figure 1 represents a vertical cross section of the cyclone separator apparatus according to the invention.

In Figure 1 a separator apparatus according to the invention is shown having a hollow circular housing (1), symmetrical around an axis (Ax), fluidly connected to a dipleg (8) a gas outlet tube (4), inlet means (3) for the gas-solids feed, tangentially arranged to create, in use, a vortex flow in the circular housing (1). The inlet means (3) is fluidly connected to an inlet conduit (2). The circular housing (1) has an upper tubular portion (5) with a diameter (D3), a frusto-conical envelope as a lower portion (6) of which the smallest diameter (D4) is at the lower end and a dust chamber (7) having a

diameter (D5). The dipleg (8) has an upper tubular part (9) of constant diameter (D1) connected to the dust chamber via the inlet (10) of the dipleg. A lower part (11) having a length (L) with diameter increasing from diameter (D1) at the top (12) of the lower part (11) to the diameter (D2) of the lower end (13) of this part (11). The angle (H) is formed by the wall of the tapered lower end and the axis (Ax). At the lower end (13) an opening which lies in the horizontal plane is shown connected to it a flapper valve (14). The flapper valve (14) is equipped with a counter weight (15) and is shown in a partly opened position in Figure 1.

The invention will be illustrated with the following non-limiting examples.

#### Example 1

In a cyclone, equipped with a dipleg having a tapered lower part, a gas/FCC catalyst feed was separated in a solids rich bottom product and a solids poor gaseous product at room temperature. The cyclone had a dipleg of 4.5 m long (the dipleg-flow was made visible by using glass) and had further the dimensions as stated in Table 1. The dipleg-lower-end was located above a fluidized bed-level, and a horizontal counterweighted flapper-valve was present. The catalyst flux in the dipleg was 30 kg/m<sup>2</sup>s. The pressure difference between the cyclone and the exterior of the dipleg was 7000 Pa. The run was continued for more than 100 minutes and no clogging of the dipleg was observed. The example was repeated at lower pressure differences and no clogging of the dipleg was observed. Only when the pressure difference was increased to values exceeding 7000 Pa clogging was observed.

#### Comparative experiment

Example 1 was repeated except that the lower part of the dipleg had a constant diameter. The pressure

difference was 4500 Pa. It was observed that, even at these low pressure difference, the solids flow leaving the dipleg stopped within 10 minutes. The dipleg was completely filled with solids and the cyclone started to discharge catalyst particles through the top-outlet.

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Table 1

Parameter	reference	Dimension	Ex. 1	Comp. Ex. A
Cyclone main diameter	D3	mm	320	320
Dipleg-main diameter	D1	mm	80	80
Dipleg-lower end diameter	D2	mm	94	80
Diverging angle	H	°	1	0
Length continuously diverging part	L	mm	400	0
Catalyst Flux		kg/m <sup>2</sup> s	30	30
Pressure difference	dP	Pa	7000	> 4500
Catalyst mean particle size		mm	0.075	0.075
Run-time		minutes	> 100	< 10

C L A I M S

1. A cyclone separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the cyclone separator comprising an upright hollow circular housing fluidly connected to a dipleg having at its lower end a flapper valve, wherein the dipleg has a lower part, which lower part has a diameter which increases from the top of the lower part to the lower end of the dipleg.

2. Apparatus according to claim 1, wherein the diameter of the lower part increases continuously and the angle formed by the inner surface of the lower part of the dipleg and the vertical axis is between  $0.2^\circ$  and  $4^\circ$ .

3. Apparatus according to claim 2, wherein the angle is between  $0.5^\circ$  and  $2^\circ$ .

4. Retrofitting an existing cyclone separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the cyclone separator comprising a dipleg having a constant diameter, wherein the lower part of the existing dipleg is modified in that this lower part has a diameter which continuously increases from the top of the lower part to the lower end of the dipleg resulting in a cyclone separator according to any one of claims 1-3.

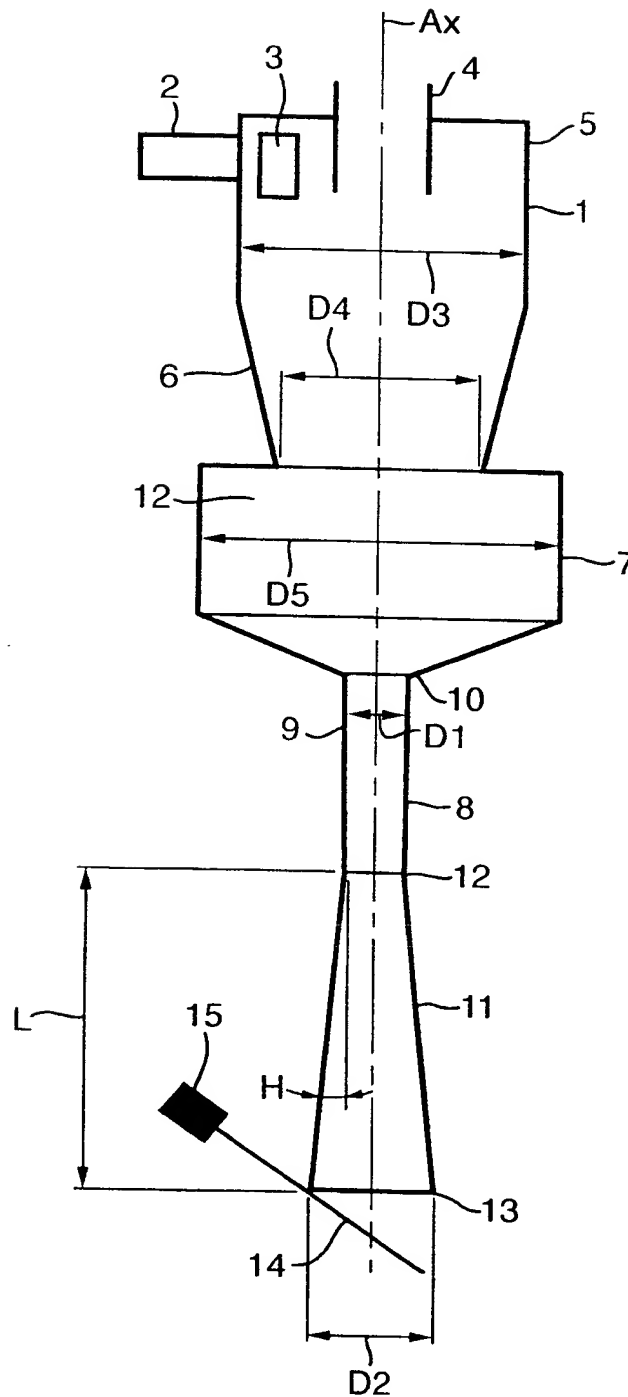
5. Process to separate gas from solids making use of the apparatus as described in anyone of claims 1-3, wherein a pressure difference exists between the cyclone housing and just beneath the outlet opening of the dipleg of between 1000 Pa and 40000 Pa, the solids have a diameter ranging between  $1 \cdot 10^{-6}$  m and  $200 \cdot 10^{-6}$  m and wherein the solids are fluid catalytic catalysts.

6. Use of an apparatus according to any one of claims 1-3, in a fluid catalytic cracking process.

5 7. Use according to claim 6, wherein the lower end of the dipleg of the apparatus according to any one of claims 1-3 is located within a vessel in which the separated solids are disposed in.



Fig.1.



JC08 Rec'd PO TO 03 MAY 2007

# PCT

## INTERNATIONAL SEARCH REPORT

(PCT Article 18 and Rules 43 and 44)

Applicant's or agent's file reference <b>TS 0762 PCT</b>	<b>FOR FURTHER ACTION</b> see Notification of Transmittal of International Search Report (Form PCT/ISA/220) as well as, where applicable, item 5 below.	
International application No. <b>PCT/EP 99/08900</b>	International filing date (day/month/year) <b>04/11/1999</b>	(Earliest) Priority Date (day/month/year) <b>06/11/1998</b>
Applicant <b>SHELL INTERNATIONALE RESEARCH MAATS..B.V...et al.</b>		

This International Search Report has been prepared by this International Searching Authority and is transmitted to the applicant according to Article 18. A copy is being transmitted to the International Bureau.

This International Search Report consists of a total of 4 sheets.

☒ It is also accompanied by a copy of each prior art document cited in this report.

### 1. Basis of the report

a. With regard to the **language**, the international search was carried out on the basis of the international application in the language in which it was filed, unless otherwise indicated under this item.

☐ the international search was carried out on the basis of a translation of the international application furnished to this Authority (Rule 23.1(b)).

b. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international search was carried out on the basis of the sequence listing :

☐ contained in the international application in written form.

☐ filed together with the international application in computer readable form.

☐ furnished subsequently to this Authority in written form.

☐ furnished subsequently to this Authority in computer readable form.

☐ the statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

☐ the statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished

2. ☐ **Certain claims were found unsearchable** (See Box I).

3. ☐ **Unity of invention is lacking** (see Box II).

4. With regard to the **title**,

☒ the text is approved as submitted by the applicant.

☐ the text has been established by this Authority to read as follows:

5. With regard to the **abstract**,

☐ the text is approved as submitted by the applicant.

☒ the text has been established, according to Rule 38.2(b), by this Authority as it appears in Box III. The applicant may, within one month from the date of mailing of this international search report, submit comments to this Authority.

6. The figure of the **drawings** to be published with the abstract is Figure No.

☒ as suggested by the applicant.

☐ because the applicant failed to suggest a figure.

☐ because this figure better characterizes the invention.

1  
☐ None of the figures.



# INTERNATIONAL SEARCH REPORT

International application No.

PCT/EP 99/08900

Box III TEXT OF THE ABSTRACT (Continuation of item 5 of the first sheet)

A cyclone separator apparatus for separating solids from a gas-solid containing feed resulting in a gas-rich stream, the cyclone separator comprising an upright hollow circular housing (1) fluidly connected to a dipleg (8) having at its lower end a flapper valve (14), wherein the dipleg (8) has a lower part (11), which lower part has a diameter which continuously increases from the top (12) of the lower part (11) to the lower end (13) of the dipleg.



**A. CLASSIFICATION OF SUBJECT MATTER**

IPC 7 B04C5/15 B01J8/00 C10G11/18

According to International Patent Classification (IPC) or to both national classification and IPC

### B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 B04C B01J C10G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

### C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A ✓	US 4 446 107 A (F. BUYAN) 1 May 1984 (1984-05-01) cited in the application column 1, line 6 - line 14 column 3, line 29 - column 5, line 12 figures 3-5	1,4-7
A ✓	US 4 871 514 A (M. ROSS) 3 October 1989 (1989-10-03) cited in the application column 4, line 18 - line 58 figure 2	1,4-7
A ✓	GB 1 194 366 A (STANDARD OIL COMPANY) 10 June 1970 (1970-06-10) figure	1,4-7

-/--

**X** Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

° Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art.

"&" document member of the same patent family

Date of the actual completion of the international search

21 February 2000

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